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# NRL TROPICAL EXPOSURE FACILITIES



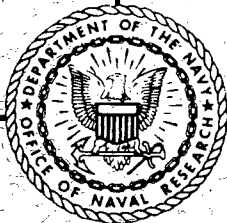
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# N R L TROPICAL EXPOSURE FACILITIES

by

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April 1947

Problem No. 32-C03-07

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## AUTHORIZATION

The maintenance of the tropical exposure station in Panama is authorized under Naval Research Laboratory Problem Number 32-CO3-07 and is carried by the Office of Naval Research as Project Number 2/47.

## ABSTRACT

In the recent war the problem of protecting material from climatic deterioration was accentuated due to the rapid failure of much of the initial equipment consigned to tropical areas. During the war a great deal of effort was directed toward the solution of this problem. In addition to the numerous endeavors made by individual laboratories throughout the country it was deemed necessary to predict actual performance on the ability of tropical equipment or material to withstand attack in actual tropical environment. Under the auspices of the National Defense Research Committee a tropical testing station was established on Barro Colorado Island in the Canal Zone. In the early part of 1946 this station was moved to the Fort Sherman Military Reservation and its administration subsequently assumed by the Naval Research Laboratory. This report describes the history of this station, the scope of its activities and planning for its widest possible use in the future. Facilities are described, which are adaptable to the study of numerous problems in tropical deterioration. These facilities are available to governmental agencies concerned with such problems. An outline is presented of the services which it can provide.

# N R L TROPICAL EXPOSURE FACILITIES

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## BACKGROUND

The story of the environmental failure of equipment and material in the recent Pacific war is familiar to many. These failures were largely the result of such natural agencies as high humidity, heavy rainfall, salt air and the micro-biological factors of bacteria, mold and insects. Items of war material which had performed nobly in other theaters of operation and in other climates were quite inadequate on Bougainville, Guadalcanal and New Guinea. Metallic items of many sorts corroded at astonishing and thoroughly alarming rates, fabrics rotted, electrical and electronic equipment, sodden with moisture and festooned with fungus, refused to operate.

Attempts to estimate the financial losses incurred are pointless. It suffices to say that a great handicap was placed upon military operations by the ravages of climate. There is no need to recount in detail the flurries of activity which were stirred in the various procuring agencies, among the manufacturers, and in the government laboratories, to obtain military equipment which could be depended upon to withstand the onslaughts of nature. Inevitably, there arose new specifications intended to cope with the emergency. Laboratory tests of these specifications were usually drafted on the basis of the best information available. The writer holds no brief against anyone for the pitiful inadequacies of many of the procedures. The stress of time and the novelty of the problems forced acceptance of laboratory methods as well as equipment and materials which were relatively untried.

Tropical environments represent complex interplays of so many imponderables that attempts at laboratory simulation seem, at times, naive. Sunlight, rainfall, high humidity, condensation, bacteria, mold, insects, dusts, temperature fluctuations and air movements are some of the individual factors involved. If one could list them all and could accurately simulate each in the laboratory, there would still be the problem of combining them in proper proportions.

The ideal solution, of course, would have been the close scrutiny of every proposed item of supply under a wide variety of natural tropical conditions. Then with a sufficiently large accumulation of data, adequate material might be supplied to the armed forces and a beginning made in the problems of devising laboratory experiments that would be reliable indices of service performance.

Though the process is slow, the gathering of reliable service data is generally acknowledged as a matter of prime importance. In several quarters, auspicious beginnings were made on this quest for valid information. Most of the service organizations have sought closer liaison between operating personnel in the military theaters and those at home who are responsible for the quality of material. At best this has been an inadequate arrangement. Complete and detailed case histories are impossible to procure; the judgment, knowledge and observations of field personnel frequently leave much to be desired.

Another attack on the problem, which holds great promise, is experimental stations located in tropical areas. These establishments can be especially valuable by virtue of having fully equipped and trained staffs who know what to look for and how to evaluate observations. Such experimental stations combine, to a considerable extent, the validity of natural exposure with the precision of the laboratory.

In the fall of 1945, the writer visited several British tropical exposure installations at Lagos, Iju, Ilogbo, Abeokuta and Port Harcourt, in Nigeria. There was no mistaking the importance which British authorities attached to the field stations. Wide varieties of valuable equipment were on exposure. Though the stations were lamentably deficient in laboratory facilities, they were amply staffed with competent specialists, supplemented by considerable numbers of Africans. The Port Harcourt station alone had a complement of twenty-five Europeans, military and civilian technicians. According to information received by the author, peace-time plans of Britain call for the perpetuation of this station under the jurisdiction of the Ministry of Supply.

Several organizations allied with the United States military services operated tropical experimental stations during the war. From the historical viewpoint those of most interest to the writer are: (1) the experimental station formerly operated under OSRD contract by the University of Pennsylvania on Barro Colorado Island and (2) the U. S. Army Ordnance Station located at Fort Sherman, both in the Panama Canal Zone. Reference (a) provides a good account of the general activities of the former station, together with a description of the topography, the climate, the flora, and the fauna of the island. The Army installation at Fort Sherman was more elaborate and extensive, providing ample facilities for the study of a great variety of ordnance equipment.

After the conclusion of hostilities in 1945, it became apparent that the two Panama stations might become casualties of reconversion. Believing that such installations have an essential function in post-war research and development, the Office of Naval Research was convinced that at least one such facility, accessible to the U. S. armed forces, should be maintained. On December 1, 1945, the Office of Naval Research assumed the OSRD contract for the operation of the Barro Colorado Island establishment. This filled an imminent gap and provided experimental facilities for the Naval Research Laboratory.

The Fort Sherman experimental station was vacated by the army group and in the spring of 1946 the station at Barro Colorado Island was moved to the Fort Sherman site. Since July 1946, the Naval Research Laboratory has been operating this installation under the auspices of the Office of Naval Research. The present location, in the Fort Sherman reservation, gives the station several marked advantages which enhance its usefulness.

## EXPOSURE STATION

### General Description

The Fort Sherman Military Reservation is a tract approximately ten square miles in area, occupying a peninsula northwest of the northern (or Caribbean) entrance to the Panama Canal. The eastern shore of the peninsula borders Limon Bay, which includes, of course, the approach to the canal. To the east, on the opposite side of Limon Bay, lies Cristobal, Coco Solo, and Colon. Travel between Fort Sherman and Cristobal is accomplished by means of a regularly scheduled ferry. Excellent highway communication via the Gatun Locks also exists.

The present facilities of the NRL tropical exposure station include the means for



exposing material and equipment to a variety of natural tropical conditions. One site, approximately four miles from Gatun and about the same distance from the Fort Sherman post proper, is situated in dense jungle, comparable in most particulars with the jungles of the south Pacific areas. Reference (b) describes the site as virtually a true rain forest. Apparently it is largely second growth, but there is good top-cover, dense undergrowth and an abundance of decaying vegetation. These conditions are ideal for studying the effects of moisture and micro-biological agents. A nearby clearing, about three hundred feet above sea level, affords opportunity for full exposure to the sun and rain and to the northeast winds from the Caribbean which generally prevail. In both the cleared area and in the jungle, samples can be exposed completely to the ravages of nature or they can be sheltered in simulations of good to poor storage conditions.

Facilities for typically marine exposures are likewise at hand on the beach of Limon Bay. This site has been used in studies of salt water corrosion. Its value for the exposure of anti-fouling materials has not yet been investigated. Though the waters around the Canal Zone generally are rich in marine fauna, intensity of fouling is apt to vary greatly with location, even in a restricted area. The Naval Research Laboratory plans to calibrate the site, so to speak, by exposing various materials of known fouling resistances.

Technical personnel of the station are housed on the Fort Sherman post. A light truck has been assigned to the station for the transportation of personnel and equipment.

#### Climate

Reference (b) presents an especially useful synthesis of climatic factors operative in the Canal Zone and the relations of these factors to deterioration studies. The area is characterized by two seasons, a wet season, about eight months in duration, extending approximately from April into December and a dry season. Somewhat more than 90% of the annual rainfall is concentrated in the wet season. The total amount of yearly rain varies across the isthmus, having a maximum of 130 to 155 inches on the Atlantic side, and decreasing fairly regularly to values of 85 inches or less on the southern or Pacific side of the Zone. The weather stations closest to Fort Sherman showed rainfalls of 130 and 126 inches for 1943 (reference (b)).

Closely identified with the high rainfall is the high humidity, an essential element in much tropical deterioration. Humidity, however, is so profoundly influenced by local conditions that standard weather station data are of little value compared with measurements made at the precise location of the experimental material. Illustrative of conditions prevailing at the jungle site are the hygrothermograph data of Tables I and II.

TABLE I  
Wet Season Conditions at Jungle Site

	Hill-top Clearing	Jungle Storage House	Jungle shed (Open sides)
Temperature, °F	79.5	77	70
Temperature range, °F	71 - 88	74.5 - 82.5	66.5 - 74.5
Relative humidity, %	94.5	97.5	93
Relative humidity range, %	68.5 - 97.5	82.5 - 98	81 - 97
Total rainfall - 12.45 inches			

- This table is a summary of daily observations made during August 1946, a typical month in the middle of the wet season.
- Average temperatures and humidities for the month are computed from the daily averages.
- Temperatures and humidity ranges are averages of daily maxima and minima.

TABLE II

## Dry Season Conditions in Jungle Site Laboratory

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Average temperatures	82 °F
Temperature range*	72 - 91° F
Average relative humidity	80%
Relative humidity range*	52 - .98%

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\* Extremes recorded during the month, not averages of daily extremes.

Dry season observations for the jungle site are limited but the data are indicative of the weather conditions.

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It is unfortunate that there are no extensive data on the duration, intensity and spectral distribution of sunlight incident upon the exposure sites. In many instances, solar radiation is the prime factor in the deterioration of weathered material, rarely can its influence be ignored. Therefore, it is planned to install equipment to measure and record the sunlight. On weathered samples the data will be an exceedingly valuable portion of the case history.

#### Facilities

As indicated in the General Description, page 2, there are two principal exposure sites. The first of these includes facilities for exposures to dense jungle conditions and to direct tropical weathering. This site includes a laboratory which is especially well equipped for electrical measurements. For example, performance determinations on radio receivers are made on the spot. Without moving the radios or otherwise altering the natural test conditions, the measurements are made and the degradations expressed in a quantitative manner. Observations are not compromised by an indeterminate damage (or recovery) which ensues during shipment to a distant laboratory. Similarly, fabric deteriorations can be measured directly with the tensile machine which is at hand. The beach site, the second of the two sites, has no laboratory facilities immediately available. From the nature of materials usually exposed at the beach site this is no shortcoming. The Technician in Charge has microscope and photographic equipment in his quarters, to be taken to the exposure site, as required.

The several large and well-equipped Army and Navy establishments in the Zone are worthy of special mention. Their availability and willingness to supply special equipment, materials and services are an invaluable asset of the station.

The establishment is under the control of a chemist and electronics engineer, assisted by skilled native labor. It is planned to augment the staff as the activities of the station warrant.

To show the variety of materials studied and thereby indicate the breadth of utility of the station, the following items are cited from the many exposed.

Navy Communications receivers	synthetic cements
binoculars	brooms
cotton fabrics	metallic corrosion panels
fungistatic varnishes	leather

The observations on these articles run the gamut from gross inspection for moldiness to complex electronic measurements with elaborate precision equipment.

### Accessibility

Proximity of the station to the port of Cristobal and to the Naval Air Station at Coco Solo is a marked convenience for shipping and travel. Coco Solo, incidentally, is a terminus of the Naval Air Transport Service. Because of the trans-isthmian highway and railroad, the station is almost as well situated with respect to Balboa, Albrook Field and other points on the Pacific side. Albrook Field is the terminus for Pan American Airways and the Air Transport Command. Since the Zone is only six hours by air from Miami, the site is almost as convenient as many points within the continental United States. In actual mileage it is closer to Washington than are some of the Western States. In this regard Panama is much more favorably situated than the British establishments in Nigeria. It is three days by air from the United Kingdom to Lagos, Nigeria and only indifferent transportation facilities exist between that point and Port Harcourt, about three hundred miles farther east.

Excellent highways in the Canal Zone permit the transportation of very heavy articles directly to the point of exposure. This advantage was one factor in the decision to vacate Barro Colorado Island in favor of Fort Sherman.

### Utilization

Though the tropical exposure station at Fort Sherman is primarily a Navy activity, it wishes to assist any branch of the government having need of its facilities. The station is open to organizations having governmental research contracts. In certain circumstances, the facilities may be made available to private firms. In such an instance the problem must be of interest to the Navy and completely identifying description of the experimental material must be supplied to Naval Research Laboratory.

In every case, the Naval Research Laboratory requests that all patrons of the station identify their samples completely. The only motives are the increase of its own knowledge and avoidance of duplication of effort. All disclosures regarding experimental material will be respected. To the limit of its facilities, the Naval Research Laboratory provides the personnel, measuring equipment and physical resources. Though considerable precaution is taken to guard against theft and non-experimental damage, the Laboratory assumes no responsibility for losses or mishaps to experimental material in its custody.

An organization desiring to send material to Panama should communicate with the Naval Research Laboratory, outlining the experiment briefly. The following information should be included:

1. Types of samples
2. Approximate numbers
3. Type of exposure sought
4. Observations desired

To allow time for proper arrangements in Panama and for the compromises which local conditions occasionally impose, every prospective user of the station is urged to write to the Naval Research Laboratory as early as possible, even when his program is in a tentative or planning stage. Natural exposure experiments, per se, frequently have low precision. In planning a project therefore, provision should be made for adequate numbers of duplicate specimen.

Correspondence concerning the station and requests for its use should be addressed as follows:

Director  
Naval Research Laboratory  
Attn: Code 820  
Washington 20, D. C.

Shipping directions will be supplied in the reply.

#### SUMMARY

The most reliable index of the environmental resistance of equipment or material is to be found in actual exposure under natural conditions.

For its tropical studies, the Naval Research Laboratory operates an exposure station in Panama. The climate is representative of the warm, humid jungles which were so troublesome during the recent Pacific war.

Organizations desiring to submit samples for natural exposure experiments are requested to communicate with the Naval Research Laboratory.

#### REFERENCES

- a. Hutchinson, W. G. and others, "The Tropical Deterioration Testing Station at Barro Colorado Island," OSRD report No. 5690, 31 October 1945.
- b. Barghoorn, E. S., "Field Studies of the Deterioration of Textiles Under Tropical Conditions," Office of the Quartermaster General, Research and Development Branch, Textile Series report No. 24, Micro-Biological Series report No. 4, June 1946.

#### ACKNOWLEDGMENTS

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